PALLET RACKING

GUIDELINES FOR DESIGN AND SAFE APPLICATION

STORAGE stow® SOLUTIONS

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SCOPE

The service manual is for the correct specification and use of various palletracking systems, such as Adjustable Palletracking, Drive-in Racking, Mobile racking and Dynamic racking systems. The racks are operated manually or automated. Other guidelines to follow are FEM 10.2.03 (Specifiers guidelines), FEM 10.2.04 (recommendations for the safe use of static racking), FEM 10.2.05 (working safely with lifttrucks and around palletracking), FEM 10.3.01 (Adjustable Palletracking : tolerances and deformations), FEM 9.831 (Rules for the design of storage and retrieval machines).

The storage equipment supplier is not responsible for the completeness of the information and the data provided in the specification. National regulations may specify other limitations and requirements.

Users of storage equipment have their own specific responsibilities for ensuring safe conditions of operation for their workers and stored goods.

The user shall observe and specify the following conditions:

1. National and local regulations are observed.
2. Assembly and erection is according the instructions provided by storage equipment supplier. Preferably the racking supplier also erect the installation.
3. Weight and dimensions of the stored goods is in conformity with the specifications.
4. Specification of the rack foundation properties, floor strength to carry the loads, its surface flatness and floor fixing limitations.
5. Specification of specific loads applied, such as crane loads, use of pallet stops, .. .
6. Specification of the site location is in conformity, such as wind loads, seismic loads, if applicable.
7. Environmental conditions, e.g. dry in order to determine the quality and durability of the paint or other steel surface treatment for its protection.
8. Specifying or providing adequate upright protections.
9. Allowing minimum clearances so that the change of collision between loads and storage equipment is minimised.
10. Regular inspections ensuring that any damage is repaired or damaged parts are replaced.
11. Provision of trained personnel to operate the storage facility safely.

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SAFETY IS PRIORITY N° 1

- RESPECT THE SAFETY REGULATIONS
- DO NOT CLIMB RACKING

- ONLY USE PALETS IN GOOD CONDITION
- FOLLOW THE UNIT LOAD HANDLING INSTRUCTIONS

- CONDUCT REGULAR INSPECTION OF RACKING, PALLETS AND TRUCKS
- REPORT ALL DAMAGE TO THE PERSON RESPONSIBLE FOR SAFETY

- DO NOT CONTINUE TO WORK WITH DAMAGED COMPONENTS
- DO NOT ALTER RACK CONFIGURATION OR TRUCK WITHOUT CHECKING TECHNICAL INFORMATION OR OBTAINING APPROVAL FROM THE SUPPLIER

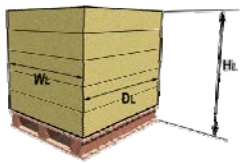
IF IN DOUBT:
ALWAYS CONTACT SUPPLIER

1. GOODSTO BE STORED

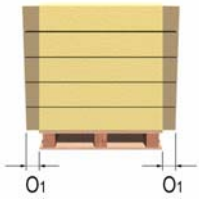
Palletracking systems are designed to store palletised goods, containers or non-palletised goods. For each category sufficient data must be furnished allowing the racking supplier designing the racking correctly.

1.1 Palletised goods

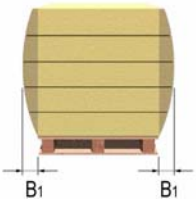
- Maximum weight of goods on one pallet.
- Type and quality of the pallet, pallet tolerances and pallet entry directions.
- Pallet load overhang, bulging and fanning.



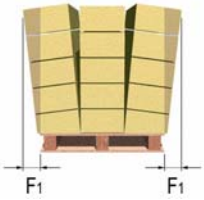
Characteristics of palletised loads that affect design clearances



Overhang



Bulging



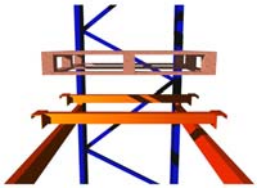
Fanning

Some examples of pallets: the supporting method is based on the pallet-characteristics.

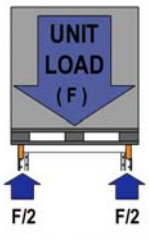
Open pallet

Closed pallet

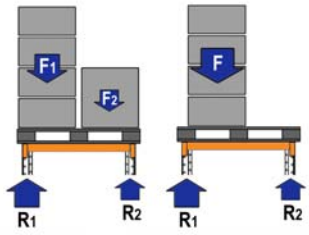
Pallet with overhang

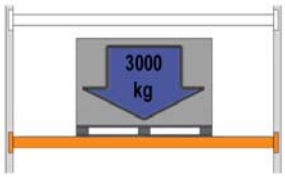

Pallet supports

Non-uniform loads result in unequally loaded beams and uprights. A maximum of 10 % for both non-uniformity of load and asymmetrical placement is acceptable.



Equally loaded



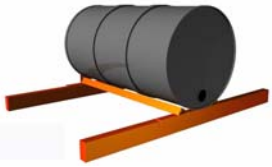


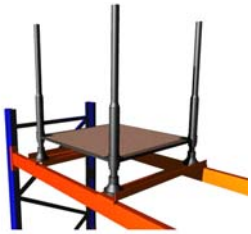
Unequally loaded situations (in depth- and length directions)

1.2 Containers, drums, bins, …

- Maximum weight of goods on or in the loading accessory.
- Exact description of the loading accessory.
- Dimensions and tolerances.

Box pallet and Post pallet with feet


Drum supports


Container supports

1.3 Non-paletised goods

- Length, width and height of each item.
- Weight of the item.
- Manner of handling (hand, pedestrian truck, …)
- Design of the decking material: wooden decking, grating, …

2. BUILDING CONDITIONS

2.1 Floor of the building

Load calculations

The user is responsible for confirming the suitability of the intended floor or foundation for the loads being imposed upon it by the racking. The standard load tables take into account that the floor is solid concrete, min. 120 mm thick and with a minimum strength of class C16/20 (ref. EC2). If the floor is made from other materials, such as bituminous compounds, the racking supplier must be informed as special consideration is needed.

Specific characteristics

The user should provide the necessary data:

- Solid concrete or other type.
- With or without a top screed.
- Thickness of the screed.
- Thickness and quality or grade of the concrete.
- The use of additives, such as "magnesite", which may corrode the metal parts.
- Size and location of the reinforcement bars.
- Position of all expansion joints.
- Position of all ducts and cables.

Floor flatness

The floor flatness is given by the document FEM 10.3.01, tables 5.1 for grade I floors, and 5.2, for grade II floors, depending on installation type (Wide aisle, Narrow aisle. Very narrow aisle. For drive-in racking up to 8 m grade I is recommended, for racks above 8 m. grade II is recommended.

Floor surface level – grade I (normal grade floors) :

For a measured grid of 1 x 1 m : 95 % of all measurements ≤ 4 mm
100 % of all measurements ≤ 5 mm

For a measured grid of 3 x 3 m : 95 % of all measurements ≤ 8 mm
100 % of all measurements ≤ 9 mm

Floor surface level – grade II (high grade floors) :

For a measured grid of 1 x 1 m : 95 % of all measurements ≤ 2.5 mm
100 % of all measurements ≤ 3 mm

For a measured grid of 3 x 3 m : 95 % of all measurements ≤ 6 mm
100 % of all measurements ≤ 7 mm

For sloping floors the maximum deviation between the highest and the lowest point may not be more then 1/1000.

2.2 Temperature

If the racks are placed in an environment where low temperatures occur, such as cold stores, the minimum and maximum temperatures must be defined.
Temperatures may vary between -25°C and +40°C.

2.3 Environmental conditions

Humidity

The degree of humidity should be provided by the user. The variation in service temperature is important in conditions that may lead to condensation forming. Special consideration should be given to hidden internal metal corrosion affecting the life of some items, such as painted beams.
For some materials, such as wood and fibreboard, the physical properties can change.

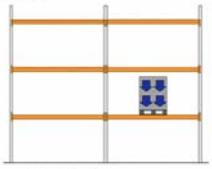
Aggressive environments

The degree of chemical pollution should be determined to specify the manner of metal protection against corrosion.

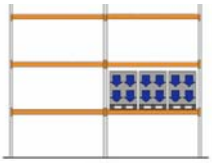
2.4 Earthquake

The location of the project must be stated by the user in order that the earthquake loads can be evaluated (refer to EC8 or National Regulations). If not explicitly specified by the user earthquake loads may be ignored. If the racking must be designed according the earthquake conditions the ground and soil conditions must be defined by the user to the racking supplier.

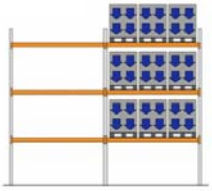
3.1 Definitions



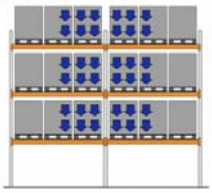
Unit load
A single load that can be placed in one operation. E.g. a pallet in a pallet racking system.



Compartment load
The load which can be loaded into one compartment of a rack, from one side.



Bay load
The total weight of all unit loads in a bay of the racking, not including any loads which may be stored on the concrete floor of the bay.



Frame load
The frame load is the total allowable weight of all unit loads transmitted to the frame by the beams attached to the frame.

The design clearances
Clear spaces around and above each unit load. These clearances enable input and output of the load without contact of the load with other loads or any part of the storage equipment other than normal contact with the beams.

Foundation
The racking foundation is the floor construction on which the equipment is erected and to which it is anchored to provide stability.

Structural design
Design of the racking system in accordance with the relevant National Regulations or European industry standards, FEM 10.2.02 (design of steel static pallet-racking).

Installation and erection
The quality and accuracy of the erection work can have a profound influence on the performance of the storage equipment. The work must be done by trained persons, properly supervised to ensure that the health and safety of all persons is safeguarded.

Pallet quality
The pallet should be of good quality and suitable for storage on beams or beam rails. Weak or damaged pallets must not be used. For special pallets (e.g. plastic- or steel pallets or containers) appropriate measures have to be taken.

Inspections
Recommendations on the frequency and level of inspections.

Floor quality
If no information is available the equipment supplier may assume for the purpose of the design of the anchorage and baseplate that the floor is solid concrete throughout its thickness, and has a minimum strength of class C16/20 (ref. Eurocode 2).

3.2 Pallet-racking

Design load capacities

The load capacities are calculated according FEM10.2.02. A change in the rack will generally cause a change in the load capacity. In all cases Stow should be consulted before the alterations are made.

The load tables are only valid under following conditions:

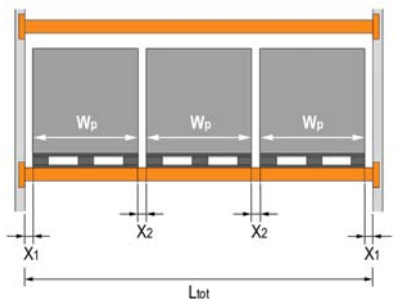
- Uniformly distributed load per pair of beams
- Min. 7 bays and 2 levels per rack
- Erection tolerance : out of plumb max. 15 mm for height > 5000 mm, 10 mm for height ≤ 5000mm.
- Frame depth = 1100 mm for pallet-depth = 1200 mm
- Concrete floor material min. strength class B16/20 (EC 2)

Vertical and horizontal racking clearances

Racking classifica tions (FEM 10.3.01)

Class	Description
100	Crane operated installations where the machines are automatically controlled, without fine positioning system
200	Crane operated installations where the machines are automatically controlled, with a fine positioning system at the storage location
300A	Very narrow aisle installations where the truck driver is raised or lowered with the unit load
300B	Very narrow aisle installations where the truck driver remains at ground level
400	Wide aisle and narrow aisle installations using counter balanced trucks or reach trucks

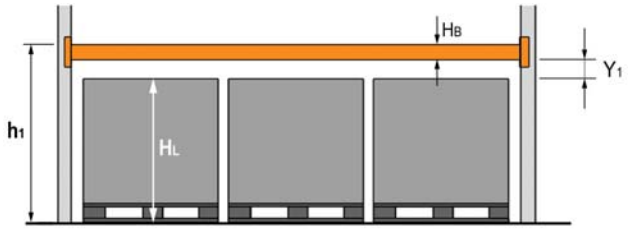
Racking tolerances



MINIMUM CLEARANCES (FEM 10.3.01)

W_P = pallet width with overload
H_L = overall pallet height

Beam level (mm)	Class 400 X1, X2	Y1	Class 300 A X1, X2	Y1	Class 300 B X1, X2	Y1
3000	75	75	-	-	-	-
6000	75	100	75	100	100	100
9000	75	125	75	125	100	125
12000	-	-	75	150	125	150



Example: beam length for 3 pallets, according FEM 10.3.01
Pallet-type EP800 (euro 800 mm), IP1000 (industrial pallet 1000 mm), EP1200 (euro1200 mm)

	Top beam level (mm)	Class 400 EP800	IP1000	EP1200	Class 300A EP800	IP1000	EP1200	Class 300B EP800	IP1000
3 pallets/ level	till 3.000	2700	3300	3900	2700	3300	3900	2800	3400
	6.000	2700	3300	3900	2700	3300	3900	2800	3400
	9.000	2700	3300	3900	2700	3300	3900	2800	3400
	12.000	-	-	-	2700	3300	3900	2900	3500

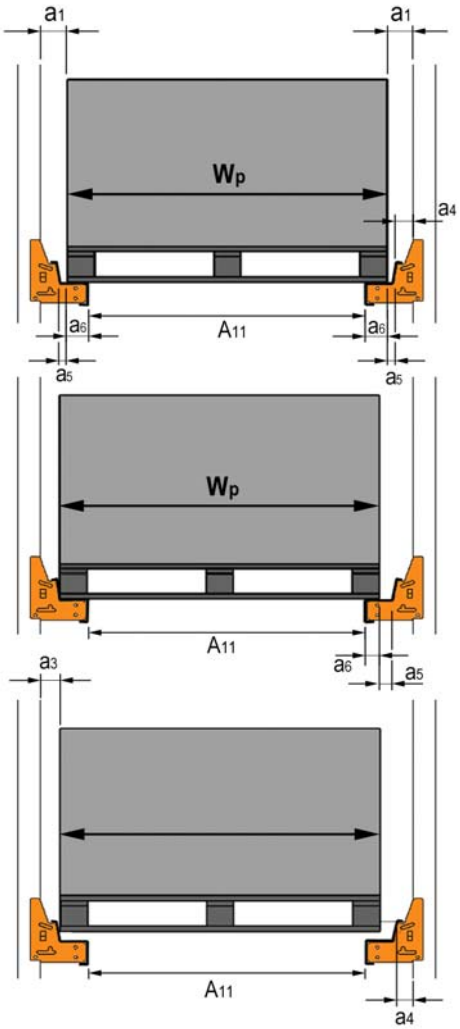
3.3 Drive-in racking

Design load capacities

The load capacity of the drive-in / drive-through installations is only valid if the loading and unloading sequence (4.3 - load handling sequence) is followed.
The initial design of the installation is related to the shape, size, material and quality of the pallets and goods. A change of pallet could have a considerable effect on the load capacity. In this case Stow must be contacted to check this new situation.

Vertical and horizontal racking clearances

Horizontal clearance



W_P = pallet width

A_{11} = pallet span

$a_1 \geq 75$ mm, depending on installation height and use.

a_3 or $a_4 \geq 45$ mm

$a_5 \geq 17.5$ mm (standard 25 mm)

$a_6 \geq 20$ mm + Δ A11

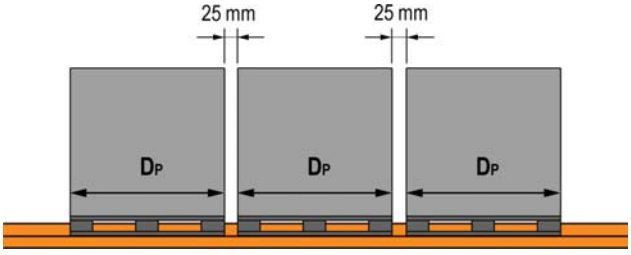
$\geq A_{11}$ = sum of the lateral bending of the uprights
= max. 15 mm per uprights
(depends on structural calculations)

E.g. : Pallet width = 1200 mm
Min. bay-width = 1350 mm
For high and deep installations the bay-widh hould be increased to 1400 mm
(less damage).

Remark : Eventual overhang, bulging or fanning of pallets shall also be taken into account when determining the clearances
(value $a_1 \geq 75$ mm, to be guaranteed in all cases).

Vertical clearance
Net clearance between top of pallet and bottom of supporting arm = 100 mm. The height of the arm is 90 mm, so top of pallet to bottom of next higher placed pallet = min. 190 mm.

Depth clearance
In general a clear distance of 25 mm is foreseen between the pallets. Overhang, bulging of fanning of pallets shall also be taken into consideration.
(see 1.1. pallet characteristics).



3.4 Mobile racking

Design load capacities

In particular for mobile racking the ratio height/depth of the racking may not exceed 5/1.
To improve the stability in both length- and cross directions vertical (back)-bracing and horizontal (plan)-bracing are foreseen.
The extra load due to acceleration and deceleration (e.g. emergency stop) is included in the static calculation. The load bearing capacity is only valid if the loading- and unloading handling sequences are followed (par. 4.4).
The stability factor for tipping of the installation due to inertia forces or horizontal loads is min. 2.

Vertical and horizontal racking clearances

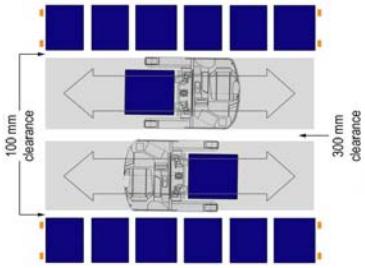
The vertical and horizontal clearances of the racking configuration (beam length and beam evel height) are identical as for normal pallet-racking.

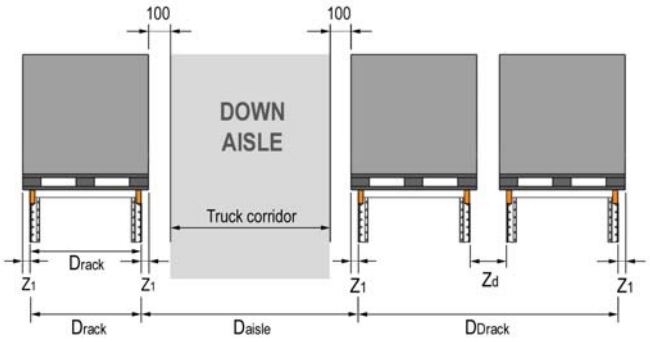
Clearance to building parts
For mobile storage equipment the distance to the walls parallel to the driving direction shall either be between 0.05 and 0.18 m over a height of minimum 2 m or at least 0.5 m.
The clearance of 0.5 m shall be measured from the most protruding part of the wall.
Near to the ground rails or parallel to the ground rails no slab settlement joints are allowed.

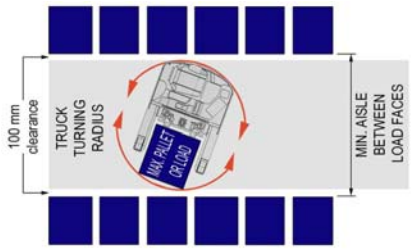
3.5 Driving clearances

Down aisle

The down aisle width is determined whether two trucks or 1 truck should be able to drive in a single aisle.
The minimum clearance between truck and the face of the pallet is 100 mm. The clearance between 2 trucks is at least 300 mm. In fast moving environments, e.g. distribution, additional clearance shall be provided. The clearance shall be minimum 175 mm.

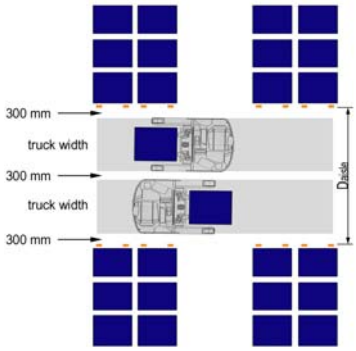






Cross aisle

The cross aisle is determined in function of the traffic speed, the intensity, turning radius, … .
Minimum clearances of 300 mm.



Other criteria

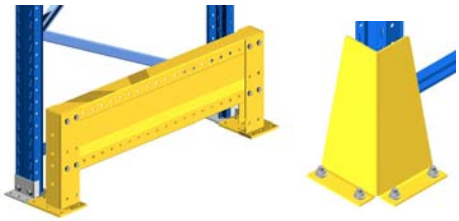
- The turning radius of the trucks
- The positioning of the pallet on the truck
- Fast or slow moving environment
- Possible temporary storage of pallets in the cross aisle
- Safety protections restrict the aisle width.
- The above specified clearances do not allow pedestrian traffic.

3.6 Safety provisions

The user has the responsibility to observe the National and local regulations and to specify the demands for safety protections.
The requirement depends on local circumstances, such as the traffic intensity, the aisle width, … .
The change of an accidental collision can be minimised by a.o. good housekeeping, operator discipline, the use of safety colours and load signs, making the truck aisle the correct width and good aisle markings.

Corner protections Frame protections - Protection of the ends of the racks

Constant traffic around the end-frames or the frames at the cross aisles often causes damage to the racking. It is recommended to protect all corners of the racking as they are vulnerable to damage caused by collisions. To protect the complete end-frame frame protectors are available in various shapes and sizes. The standard Stow frame protector is built with sigma main beam, supported by two end protectors. For longer runs intermediate supporting brackets are mounted.



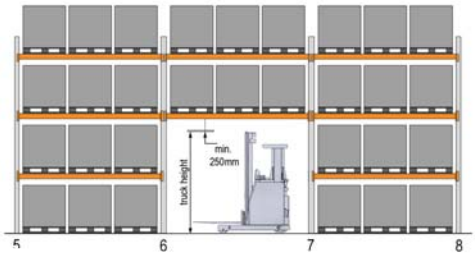
Front protection of the upright

The upright protector will reduce the damage caused by impact loads.
Especially for installations with fast moving products or heavy products upright protectors are essential for the safety and durability of the racking.

Extended end-frames – precautions to prevent goods falling from racks

Consideration should be given to frames at the ends of the run. These frames should be extended according the National Safety Regulations (e.g. Germany: 0.5 m, France: 1 m, ...).

Fall-through protections



Depending on the National and local Safety

Standards fall-through protections may be needed above the cross gangways. The design of the fall-through protection depends on the type and weight of the stored goods or pallets. Wire mesh, grating, metal or wooden decking may be applied.

Pallet back-stops

A buffer pallet back-stop: is used by the lift-truck driver to deposit a unit load on its correct position in the rack. The extra loads onto the racking must be included in the design load capacity.
A safety back-stop: a safety back-stop to prevent accidental damage or to prevent goods from falling into an aisle. In this case the racking will only accidentally be impacted. The position of the stop and the required clearance must be agreed with the racking supplier. Sometimes mesh screen is fixed on the back of the racks to provide a safety device against unintentional load movements or to prevent loads falling of the rack.

Provision of edge guarding - rack supported floors and mezzanines

The consequences of people falling of heights are so dangerous that a high standard of protection is required. One safe method where goods are raised or lowered by means of a lift truck is to provide pallet gates. The requirements for edge guarding are controlled by the National Safety Standards.

4. UNIT LOAD HANDLING SEQUENCE

4.1 The placing of unit loads

1. Unit loads: It is not permitted to place heavier loads in storage equipment than those prescribed by Stow and shown on the load notices.
   Only the type and quality of unit loads specified to Stow can be safely placed on the racking. Additional supporting accessories have to be used properly.
2. Load stability: The goods shall be stacked or palletised such that they cannot fall.
3. Unit load clearances: The actual dimensions of the pallets and goods shall not conflict with the clearances provided for safe operation.
4. Pallets must be loaded and picked from racking with care by trained people.
5. The pallets shall be correctly orientated as specified and properly positioned on the storage equipment supporting members.
6. Timber pallets must be placed in a rack such that the pallet bearers span the space between beams.
7. Pallets should be placed as symmetrically as possible with respect to a pair of pallet-racking beams. In general a normal overhang from the face of the beam of the pallet will be up to 50 mm.
8. Where the lowest pallet in a rack is supported on the floor, a permanent line should be drawn down each side of each aisle to mark the position at which the front face of the pallet should be placed.

4.2 Method of placement – Pallet racking systems

When a pallet is being placed into a pallet rack, the following sequential loading activities take place:

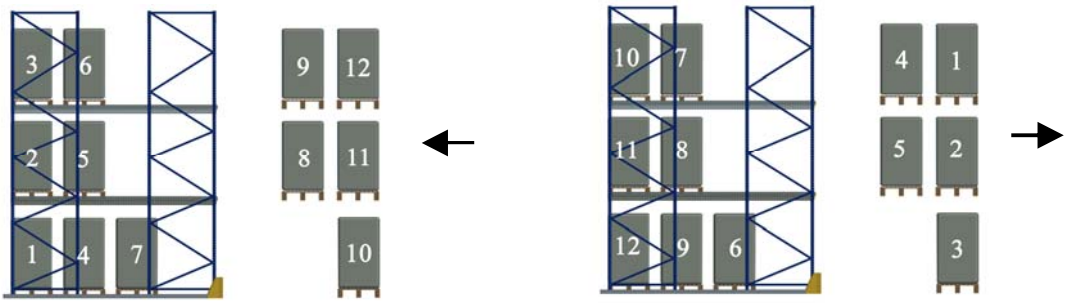
1. The fork lift truck drives with a pallet to the pallet rack storage location.
2. The driver raises and manipulates the pallet into the racking compartment clear of the rack uprights with no forward tilt of the forks.
3. The driver positions the pallet correctly in the depth of the rack with regard to the pallet rack beams. Before lowering the pallet there is no contact with the beams.
4. The driver lowers the pallet carefully onto the beams and releases the load from the forks.
5. The driver removes the forks from the pallet and lowers them to the ground.

4.3 Method of placement – Drive-in racking systems

When a pallet is being placed into a pallet rack, the following sequential loading activities take place:

1. The fork lift truck drives with a pallet to the pallet rack storage location.
2. The driver raises and manoeuvers the pallet into the racking lane, clear of the rack uprights with no forward tilt of the forks, at the required storage level and with the pallet positioned centrally between the pallet rails.
3. The truck is driven forward from the entry to the set down position, keeping the pallet clear of contact with the pallet rails.
4. The driver lowers the pallet carefully onto the pallet rails and releases the load from the forks.
5. The driver removes the forks from the pallet, reverses the truck carefully back out of the lane and then lowers the forks.
6. The truck speed is critical for a safe operation. To prevent the mast from flexing excessively on uneven floors and striking the pallet rails the truck speed must be regulated to suit the floor flatness and the mast flexibility.
7. The loading and unloading sequence of the loads shall be followed (see next page).
8. It is prohibited to drive or pass underneath stored pallets, not by the lifttruck, nor by the driver.

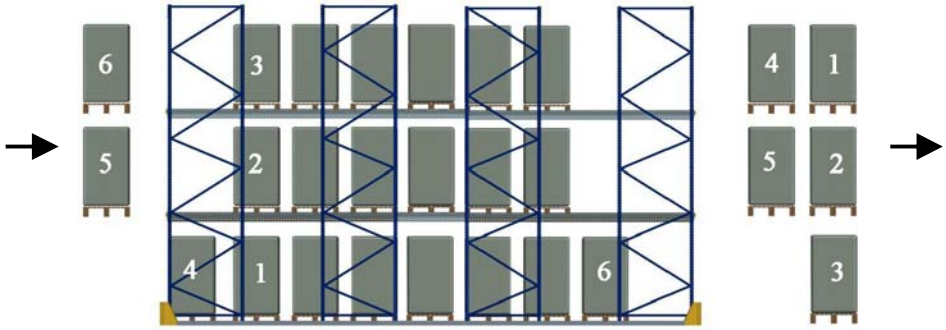
Loading/ unloading sequence of Drive-in racking



On the input cycle the first pallet is placed at position 1 and the rack is loaded from the towards bottom upwards from the back outwards.

On the output cycle the procedure is the reverse, from the top down working in the back of the drive-in.

Loading/ unloading sequence of Drive-through racking



The loading and unloading cycle is similar. The loading and unloading happens from opposite sides. In general the loading happens from the bottom upwards and from the back outwards (from pallet 1 to 6 on the left side), the unloading happens from the top downwards, working in towards the back of the drive-through rack (starting with pallet 1 on the right side).

4.4 Method of placement – Mobile racking systems

Only authorised people shall start and operate the system.
The instructions in the "Operating manual Mobile racking" shall be followed.

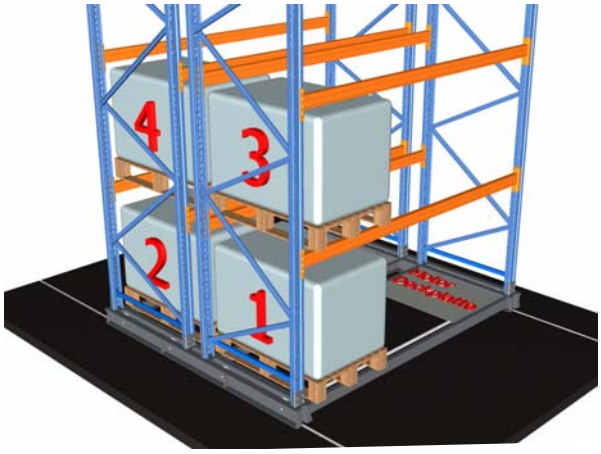
When a pallet is being placed into a pallet rack, the following sequential loading activities take place:

1. The fork lift truck drives with a pallet to the pallet rack storage location.
2. The driver raises and manipulates the pallet into the racking compartment clear of the rack uprights with no forward tilt of the forks.
3. The driver positions the pallet correctly in the depth of the rack with regard to the pallet rack beams. Before lowering the pallet there is no contact with the beams.
4. The driver lowers the pallet carefully onto the beams and releases the load from the forks.
5. The driver removes the forks from the pallet and lowers them to the ground.
6. The truck speed is critical for a safe operation. To prevent collisions with the mobile bases or racking the truck speed must be regulated accordingly.
7. The loading and unloading sequence of the loads shall be followed (see next page).

4. UNIT LOAD HANDLING SEQUENCE

Loading/ unloading sequence of Mobile racking

The loading of the pallets shall start at the bottom level at the side where the motor is installed (pallet 1). After the first compartment is loaded the loading shall follow at the opposite side (pallet 2), again on bottom level.



This process is repeated from the bottom upwards to the top.

ATTENTION: both sides of the double rack shall be equally loaded as much as possible. An unbalanced loading between both sides of the racking of maximum 50% shall be maintained.

4.5 Method of placement – Live storage systems

Principle:

The live storage system is composed of a number of gravity lanes, built in a solid block of storage. A pallet is inserted at the onload face and is then released into the storage lane until each lane has been filled. The storage lanes are installed at a small gradient, so once the pallet at the offload face has been removed the pallets stored behind automatically feed forward under the force of gravity.

Loading and unloading sequence:

1. Check the underside of the pallet for loose, split or damaged boards and projections, such as nails and loose stretch wrapping.
2. Align the pallet centrally with the unload module using the pallet guides as indicator.
3. With sufficient vertical clearance move the pallet straight into the rack location.
4. Gently place the pallet onto the roller track and lower the forks and withdrawn from the pallet.
5. Unloading: raise the pallet sufficiently to clear the end stop (not too high as the separator may not be released) and withdrawn squarely. The separator will hold back the queue of pallets until the first pallet is removed.
6. Remark: if no separator is fitted the queue of pallets will move as the first pallet is withdrawn. In this case the withdrawal speed shall be regulated such that the impact by the following pallets on the front stop is not too excessive.

5. CHANGES TO THE CONFIGURATION

A change in the rack will generally cause a change in the load carrying capacity. In braced or unbraced racking, if the height of the first beam level or the space between the beams is increased, the load capacity of the rack will be reduced.
If the rack is re-located and the floor conditions are not the same the design load capacities may also change.

In all cases of changes Stow should be consulted before the alterations are made.

The changes should be made in a professional manner and in accordance with Stow's instructions. During the alterations the rack must be unloaded. The safe load notices must be replaced as necessary after the changes of the rack. In the case of back-braced racking, if the beam levels are changed, the bracing node points will have to be changed. The corresponding horizontal bracings have to be re-located as well.

A safety review of the installation should also be conducted if following changes of the storage equipment have been implemented:

- A change of type or make of lift-truck
- A change in the method of handling unit loads or the pallet types used.
- A change in the type of goods being handled.
- Introduction of overhanging loads on pallets.
- An increase in the amount of storage equipment damage being sustained.

6. REGULAR INSPECTIONS

The inspection of all storage equipment should be done systematically on a regular basis.
Competent personnel, in-house staff or external specialists, should carry out these inspections.

Basic inspections

- Inspection of load and information notices specifying the safe load capacities and check if these are up to date to the installation, which may have been modified after the previous inspection.
- Inspection of the upright and corner protections. These protections are intended as sacrificial protection and should be replaced once they are damaged and ineffective.
- Inspection of the overload damage to beams or shelfs: if permanent deformation has occurred the beams or shelves have been overloaded.
- Inspection of the beam connector locks. If the lock is missing it should be added immediately to prevent accidental dislodgement of beams.
- Inspection of frame uprights for out of verticality: if the out of plumb is larger then H/200 due to various reasons (floor settlements, overloading, …) it will reduce the safe load capacity of the uprights.
- Inspection of all damages according the specifications in par. 8 ("evaluation of damaged components").

Inspection schedule

Daily inspections

Inspections are daily made by lift-truck drivers and warehouse personnel. Damages or safety problems detected have to be reported immediately to the management.

Weekly and monthly inspections

The Safety Officer should make on a weekly and monthly basis inspections and submit formal written reports to the management.
The damage should be categorised as RED or ORANGE RISK, see par. 7.

Six to twelve monthly inspections by an expert

The Expert (in-house staff or external specialist) should make a thorough inspection and submit formal written reports to the management with observations and proposals for actions.

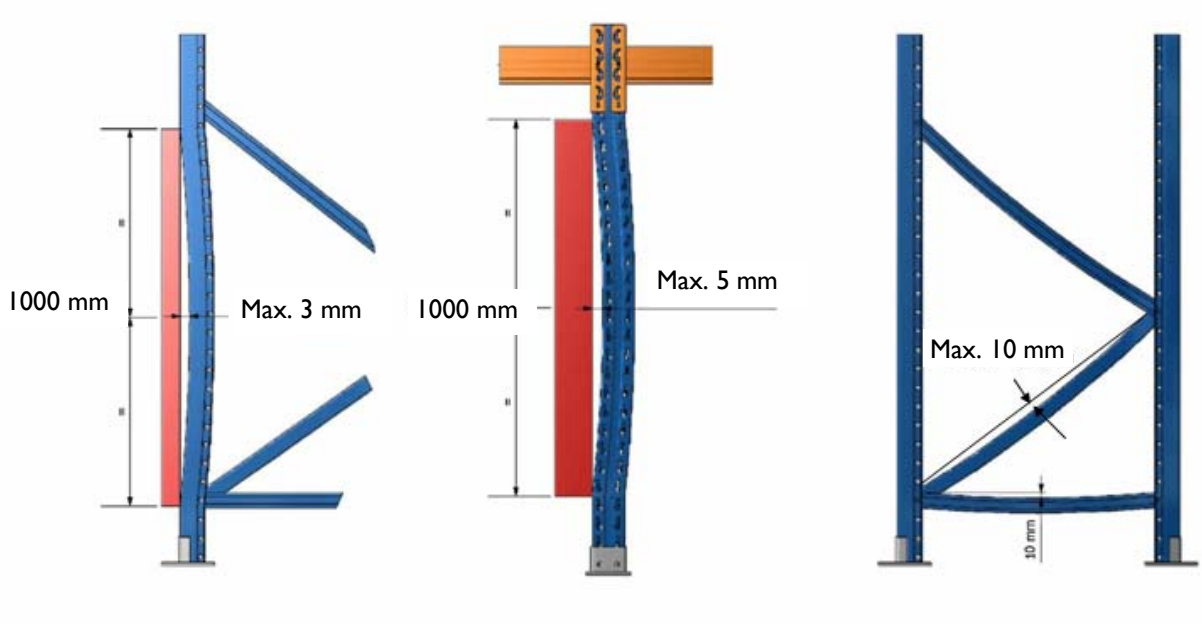
7. EVALUATION OF DAMAGED PARTS

EVALUATION OF UPRIGHTS AND FRAME DIAGONALS

An inspection report of rack damage should initiate a management procedure for isolating and making safe sections of racking that are seriously damaged and initiate an effective replacement of damaged parts.

In order to evaluate and classify damages in respect of the safety level, following measurement methods have to be implemented (FEM 10.2.04):

1. Straightness of the upright in depth direction (plane of the frame) : gap max. 5 mm over a straight edge of 1000 mm. Localised bends over a length of less then 1 metre may be judged pro-rata to the 1 metre limits.
2. Straightness of the upright in length direction (direction of the beams) : gap max. 3 mm over a straight edge of 1000 mm. Localised bends over a length of less then 1 metre may be judged pro-rata to the 1 metre limits.
3. Bracing bent in either plane : gap of max. 10 mm between the straight edge.



GREEN RISK
The damages measured are within the damage limits of above figures:
The damages are considered as non-critical, but should be reviewed at next inspections.

ORANGE RISK
The damages measured are exceeding the damage limits up to a factor of 2:
Remedial work must be initiated, but immediate off-loading of the rack is not needed. Once the rack is unloaded it should not be re-loaded until the repairs have been carried out. This means that racking with ORANGE RISK becomes RED RISK when the rack is unloaded.

RED RISK
The damages measured are exceeding the damage limits by a factor greater then 2:
The racking must be off-loaded immediately and isolated from future use until repair work is carried out.

REMARK
It is not recommended to repair damaged components.
The damaged components should be replaced by the racking supplier.

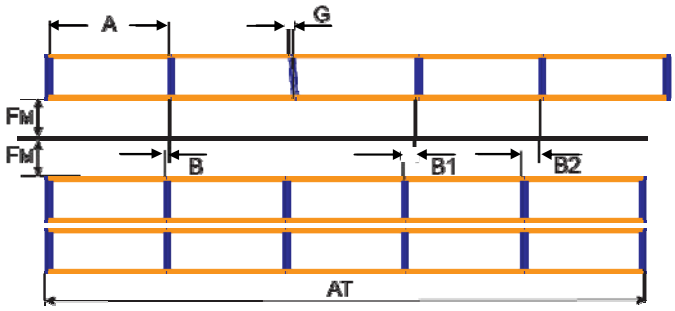
EVALUATION OF BEAMS

1. Residual vertical deformation, due to accidental overloading or damage, should not exceed 20% of normal deflection under full load. Beams showing a greater residual deflection shall be replaced.
2. Beams with end connectors that show visible deformation or damage shall be replaced.
3. If welds between beam and connector show signs of cracking, the beams have to be replaced.

8. ASSEMBLYTOLERANCES

The assembly of the various racking systems shall be executed according the corresponding "Assembly Instructions". Please contact Stow if these are not available on site.
The assembly instructions describe the racking components, the assembly procedures and the assembly tolerances.
Complex racking systems, such as drive-in racking, live storage systems, mobile racking, … shall be installed by specialised assembly teams.
For conventional palletracking the assembly tolerances are listed hereafter.

Conventional pallet-racking - Tolerances in XZ-plane



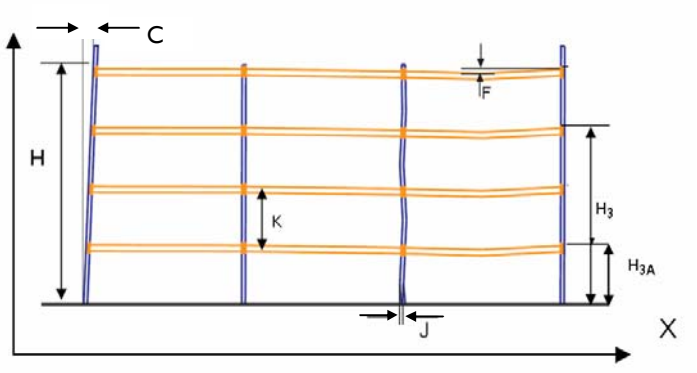
Tolerance	Tolerance description	Class 400	Class 300A	Class 300B
A	Variation of dimension of the clear entry between uprights at any beam height	± 3 mm	± 3 mm	± 3 mm
AT	Variation of total rack length after n-bays, measured at floor level	± 3n mm	± 3n mm	± 3n mm
B (B1...Bn)	The misalignment between opposite uprights, cumulative after n-bays	Max. of (± 10 mm or ± 1.0n)	Max. of (± 10 mm or ± 1.0n)	Max. of (± 10 mm or ± 0.5n)
FM	Variation of the straightness of the aisle with regard to the aisle center line	± 15 mm	± 10 mm	± 10 mm

Palletracking tolerance classes

Class 400	Narrow and wide aisle installations using reach trucks
Class 300A	Very narrow aisle installations, man-up operation
Class 300B	Very narrow aisle installations, man-down operation

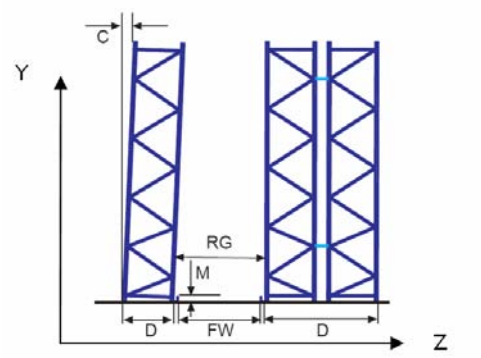
8. ASSEMBLYTOLERANCES

Conventional palletracking Tolerances in XY-plane



Tolerance	Tolerance description	Class 400	Class 300A	Class 300B
C	Out of plumb of each upright in x-direction	Max. (± 10 mm or ± H / 350)	Max. (± 10 mm or ± H / 500)	Max. (± 10 mm or ± H / 500)
J	Upright straightness in x-direction between beams, spaced K apart	Max. (± 3 mm or ± K / 400)	Max. (± 3 mm or ± K / 750)	Max. (± 3 mm or ± K / 750)
H_3	The variation of the top of any beam level H_3 above the reference line (0-line)	Max. (± 10 mm or ± H_3/ 400)	Max. (± 10 mm or ± H_3/ 400)	± 5 mm
H_{3A}	The variation of the top of first beam level above the reference line (0-line)	-	± 5 mm	± 5 mm

Conventional pallet-racking Tolerances in YZ-plane



Tolerance	Tolerance description	Class 400	Class 300A	Class 300B
C	Out of plumb of each upright in z-direction	Max. (± 10 mm or ± H / 350)	Max. (± 10 mm or ± H / 500)	Max. (± 10 mm or ± H / 750)
D	Variation in rack depth (single and double)	± 3 mm	± 3 mm	± 3 mm
RG	Variation of aisle width at floor level	± 20 mm	± 5 mm	± 5 mm
FW	Variation of width between ground rails	-	+5/-0 mm	+5/-0 mm
M	Variation of the top of the ground rail	-	± 5 mm	± 5 mm